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**A VALIDATION AND STATISTICAL
EVALUATION OF JUNE 2010
GROUNDWATER QUALITY DATA
CITY OF HELENA LANDFILL**

Prepared For:

**CITY OF HELENA
HELENA, MONTANA**



Hydrometrics, Inc.
consulting scientists and engineers

AUGUST 2010

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AUG 25 2010

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Dept. of Environmental Quality
Waste & Underground
Tank Management Bureau

**DATA VALIDATION AND STATISTICAL
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Helena, MT 59601
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August 24, 2010

Mr. Martin Van Oort
Environmental Science Specialist
Solid Waste Regulatory Program
Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901

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AUG 25 2010

Dept. of Environmental Quality
Waste & Underground
Tank Management Bureau

RE: Data Validation and Statistical Evaluation of June 2010 Groundwater Quality Data

Dear Martin,

On behalf of the City of Helena, Hydrometrics validated and statistically evaluated groundwater quality data for samples collected at the City's municipal landfill in June 2010. After receiving approval from John Rundquist of the City of Helena, I am forwarding a copy of the report "Data Validation and Statistical Evaluation of June 2010 Groundwater Quality Data City of Helena Landfill" for your review.

If you have any questions concerning this report, please don't hesitate to call.

Sincerely,

Jodi Bingham, P.E.
Environmental Engineer/Chemist

Enclosure

c: John Rundquist, City of Helena, without Enclosure
Ben Sautter, City of Helena, without Enclosure
Mike Wignot, Hydrometrics, without Enclosure

**DATA VALIDATION AND STATISTICAL
EVALUATION OF JUNE 2010
GROUNDWATER QUALITY DATA**

CITY OF HELENA LANDFILL

Prepared for:

Mr. John Rundquist
CITY OF HELENA
City/County Building
316 North Park Avenue
Helena, MT 59623

Prepared by:

Hydrometrics, Inc.
3020 Bozeman Avenue
Helena, MT 59601

August 2010

TABLE OF CONTENTS

Page

LIST OF TABLES	ii
LIST OF FIGURES.....	iii
LIST OF APPENDICES	iii
1. REPORT OBJECTIVES	1-1
2. SITE DESCRIPTION	2-1
2.1 PHYSICAL FEATURES.....	2-1
2.2 WELL LOCATIONS.....	2-1
2.3 GROUNDWATER FLOW DIRECTION AND VELOCITY	2-4
2.4 CURRENT ACTIVITIES.....	2-5
3. SUMMARY OF JUNE 2010 DATA VALIDATION REPORT.....	3-1
4. STATISTICAL DATA EVALUATION AND COMPARISON.....	4-1
4.1 DOWNGRAIDENT WATER QUALITY COMPARISONS WITH CRITERIA AND UPGRADIENT WATER QUALITY	4-1
4.2 INTER-WELL PREDICTION INTERVAL ANALYSIS	4-7
4.3 TREND ANALYSIS	4-9
4.4 TEMPORAL CONCENTRATION PLOTS.....	4-10
4.5 CROSS-GRADIENT DATA EVALUATION.....	4-14
5. IRRIGATION WELL AND DOMESTIC WELL DATA EVALUATION.....	5-1
6. SUMMARY AND CONCLUSIONS	6-1
7. REFERENCES	7-1

LIST OF TABLES

TABLE 2-1. GROUNDWATER VELOCITIES	2-4
TABLE 4-1. SUMMARY OF PARAMETER CONCENTRATIONS IN LANDFILL MONITORING WELLS FOR THE JUNE 2010 MONITORING EVENT	4-2

TABLE 4-2.	COMPARISON OF DOWNGRAIDENT CONCENTRATIONS WITH BACKGROUND CONCENTRATIONS AND MCLs FOR THE JUNE 2010 SAMPLING EVENT	4-3
TABLE 4-3.	COMPARISON OF DOWNGRAIDENT CONCENTRATIONS WITH BACKGROUND CONCENTRATIONS AND MCLs FOR ALL SAMPLING EVENTS TO DATE	4-4
TABLE 4-4.	RESULTS OF INTER-WELL PREDICTION INTERVAL TESTS	4-8
TABLE 4-5.	RESULTS OF MANN-KENDALL TREND ANALYSES	4-9

LIST OF FIGURES

FIGURE 2-1.	VICINITY MAP	2-2
FIGURE 2-2.	STUDY AREA AND JUNE 2010 POTENTIOMETRIC SURFACE	2-3
FIGURE 4-1.	TEMPORAL TRENDS IN TETRACHLOROETHENE CONCENTRATIONS AT SELECTED MONITORING WELLS	4-11
FIGURE 4-2.	TEMPORAL TRENDS IN NITRATE CONCENTRATIONS AT SELECTED MONITORING WELLS	4-13
FIGURE 5-1.	TEMPORAL TRENDS IN PCE CONCENTRATIONS IN DOMESTIC AND IRRIGATION WELLS	5-2

LIST OF APPENDICES

APPENDIX A	DATA VALIDATION REPORT
APPENDIX B	STATISTICAL ANALYSIS REPORTS

**DATA VALIDATION AND STATISTICAL
EVALUATION OF JUNE 2010
GROUNDWATER QUALITY DATA
CITY OF HELENA LANDFILL**

1. REPORT OBJECTIVES

This report is prepared on behalf of the City of Helena Landfill to fulfill the groundwater data evaluation requirements provided in Administrative Rules, Montana (ARM) Title 17, Chapter 50. This report provides analytical results for groundwater samples collected at monitoring wells during the June 2010 monitoring event, summarizes, the data validation results and statistically evaluates the data. The samples were collected and analyzed in accordance with the Montana Department of Environmental Quality (MDEQ) approved sampling and analysis plan (Hydrometrics, 2008). This plan includes a reduction in sampling compared to the previously approved sampling program.

ARM 17.50.708(12) and ARM 17.50.708(13) stipulate the types of statistical data evaluations to be performed on groundwater quality monitoring data from regulated landfills. Federal guidance on conducting statistical evaluations of groundwater data is also available (EPA, 1989; EPA, 1992). These regulations and guidance documents allow the use of a wide range of statistical procedures including: parametric analysis of variance, non-parametric analysis of variance, tolerance or prediction interval testing, trend tests, or other statistical tests meeting the statistical testing objectives of the rules.

Statistical evaluations have been performed for this site semiannually since 1993 and the following conclusions have been reached based on the results of those evaluations:

- Chlorinated hydrocarbons occur downgradient of the landfill;
- Tetrachloroethene (PCE) is the chlorinated organic compound of greatest concern due

to Maximum Contaminant Level (MCL) exceedances;

- Concentrations of PCE are decreasing over time in well EPA-1, the well that has historically shown the highest concentrations, and in compliance wells HL-90-1, HL-99-1, HL-99-2, and HL-99-3; and
- Elevated nitrate plus nitrite as N (nitrate) concentrations exist both upgradient and downgradient of the landfill at similar levels.

These findings are further evaluated in this June 2010 statistical report through an assessment of current concentrations (Table 4-1), a comparison of summary statistics (Tables 4-2 and 4-3), an inter-well prediction analysis (Table 4-4), and an examination of temporal trends (Table 4-5 and Figures 4-1 and 4-2).

2. SITE DESCRIPTION

2.1 PHYSICAL FEATURES

A site location map is provided in Figure 2-1. The landfill is surrounded for several miles in all directions by residential, commercial and industrial zoned property. There are several businesses upgradient of the landfill, which have the potential to affect groundwater quality in the area.

A site plan is shown on Figure 2-2. The landfill is divided into three sections. The southern part of the landfill (Phase I and Phase II sections) is unlined and was in operation until the early 1980s. The northern part of the landfill (Phase III) is also unlined, and was in operation until November 1993. The Phase III landfill has been capped with an 18-inch clay cover to minimize surface water percolation through the landfill and subsequent migration of chemicals into groundwater.

2.2 WELL LOCATIONS

Fifteen monitoring wells located around the landfill were included in the June 2010 groundwater monitoring program and are characterized as follows:

- Background wells: HL-06-1 (replaced 83-6), HL-94-1R, HL-94-2R, MPC-5;
- Downgradient wells: HL-10-1, HL-90-1, HL-90-2, HL-90-3, MPC-1, MPC-2, EPA-1, HL-99-1, HL-99-2, HL-99-3; and
- Cross-gradient well: HL-94-3.

As discussed in Section 2.4 and in accordance with the approved sampling and analysis plan (Hydrometrics, 2008), all fifteen of these wells were sampled during the June sampling event. A new compliance well, HL-10-1, located just west of well HL-90-1, was drilled in May of this year and completed at greater depth than HL-90-1 to provide more reliable sampling. The locations of these wells are shown in Figure 2-2.



NO SCALE

CITY OF HELENA LANDFILL
DATA VALIDATION & STATISTICAL
EVALUATION OF JUNE 2010
GROUNDWATER QUALITY DATA

VICINITY MAP

FIGURE

2-1



SITE CODE	DTWL	MPE	SW L
Jun-10			
HL-06-1	19.20	3993.62	3974.42
82-3	67.84	3973.51	3905.67
EPA-1	48.38	3981.08	3932.70
EPA-4	72.43	3973.83	3901.40
HL-10-1	59.25	3943.01	3883.76
HL-90-1	58.60	3942.48	3883.88
HL-90-2	49.67	3950.96	3901.29
HL-90-3	64.50	3958.29	3893.79
HL-94-1R	59.75	3994.04	3934.29
HL-94-2R	31.84	3967.64	3935.80
HL-94-3	36.79	3967.38	3930.59
HL-99-1	62.81	3943.15	3880.34
HL-99-2	89.11	3945.75	3856.64
HL-99-3	73.18	3948.05	3874.87
INF. GALLE	6.91	3918.89	3911.98
I-1	64.77	3899.59	3834.82
MPC-1	23.48	3946.08	3922.60
MPC-2	17.19	3936.09	3918.90
MPC-5	58.66	3990.14	3931.48



SCALE

0 (In Feet) 800

LEGEND

HL-1 ■ PIEZOMETER

83-6 ● MONITORING WELL

I-8 ▲ IRRIGATION WELL

80 □ DOMESTIC WELL

INFILTRATION GALLERY (GROUNDWATER COLLECTION SYSTEM)

AREA OF SHALLOW LOW PERMEABILITY BEDROCK

POTENTIOMETRIC CONTOUR LINE

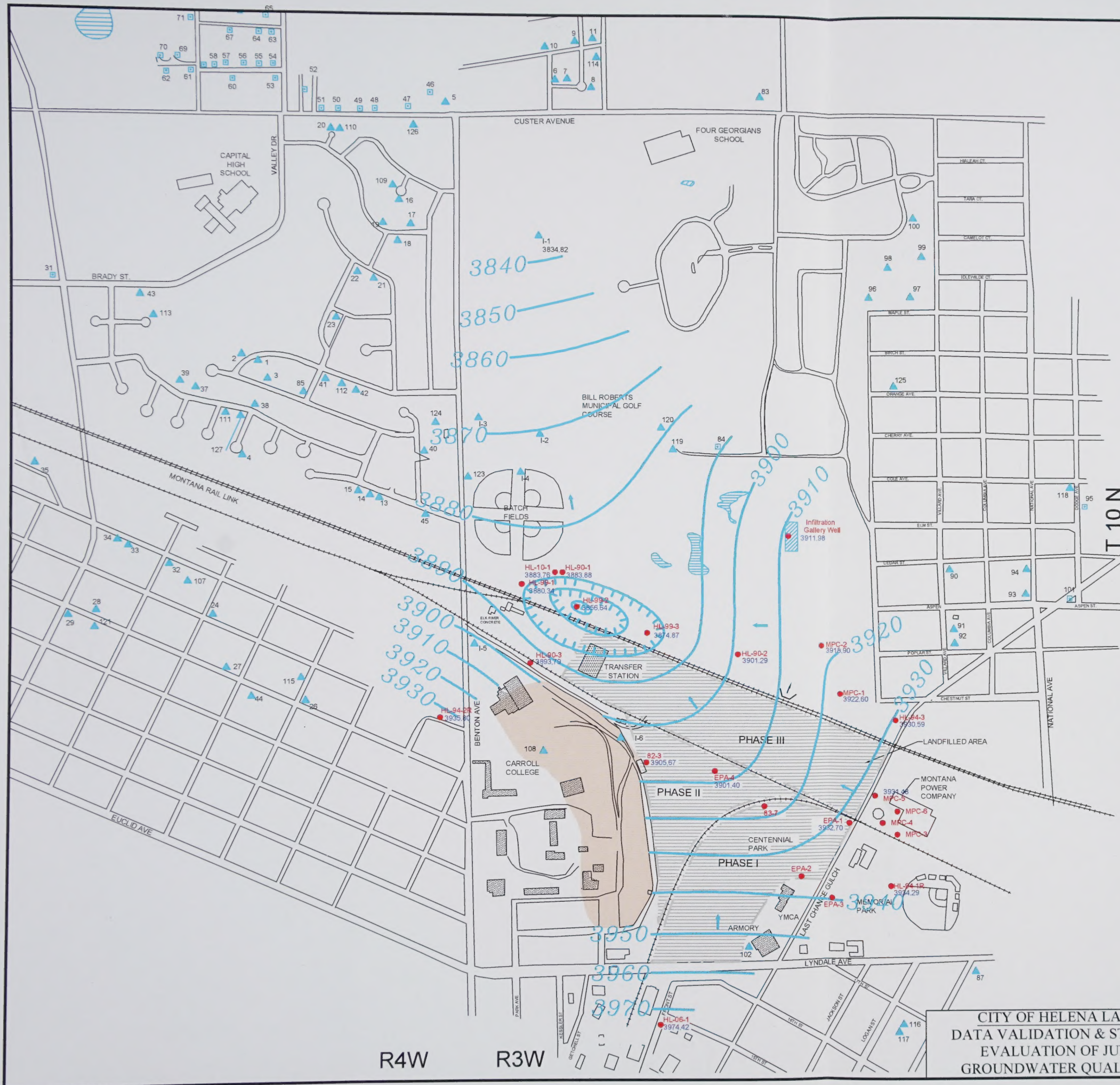
INFERRED GROUNDWATER FLOW DIRECTION

STORM WATER OUTFALL FOR LAST CHANCE GULCH

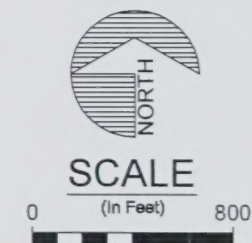
STUDY AREA AND JUNE 2010
POTENTIOMETRIC SURFACE

FIGURE

2-2



SITE CODE	DTWL	MPE	SWL
Jun-10			
HL-08-1	19.20	3993.62	3974.42
82-3	67.84	3973.51	3905.67
EPA-1	48.38	3981.08	3932.70
EPA-4	72.43	3973.83	3901.40
HL-10-1	59.25	3943.01	3883.76
HL-90-1	58.60	3942.48	3883.88
HL-90-2	49.67	3950.96	3901.29
HL-90-3	64.50	3958.29	3893.79
HL-94-1R	59.75	3994.04	3934.29
HL-94-2R	31.84	3967.64	3935.80
HL-94-3	36.79	3967.38	3930.59
HL-99-1	62.81	3943.15	3880.34
HL-99-2	89.11	3945.75	3856.64
HL-99-3	73.18	3948.05	3874.87
INF. GALLE	6.91	3918.89	3911.98
I-1	64.77	3899.59	3834.82
MPC-1	23.48	3946.08	3922.60
MPC-2	17.19	3936.09	3918.90
MPC-5	58.66	3990.14	3931.48



LEGEND

- HL-1 ■ PIEZOMETER
- 83-6 ● MONITORING WELL
- I-8 ▲ IRRIGATION WELL
- 60 □ DOMESTIC WELL
- INFILTRATION GALLERY (GROUNDWATER COLLECTION SYSTEM)
- AREA OF SHALLOW LOW PERMEABILITY BEDROCK
- 3900 — POTENTIOMETRIC CONTOUR LINE
- INFERRED GROUNDWATER FLOW DIRECTION
- ↘ STORM WATER OUTFALL FOR LAST CHANCE GULCH

CITY OF HELENA LANDFILL
DATA VALIDATION & STATISTICAL
EVALUATION OF JUNE 2010
GROUNDWATER QUALITY DATA

STUDY AREA AND JUNE 2010
POTENTIOMETRIC SURFACE

FIGURE
2-2

2.3 GROUNDWATER FLOW DIRECTION AND VELOCITY

Figure 2-2 shows water level elevations observed in June 2010 and groundwater potentiometric surface contours. Groundwater flow direction is also shown on this figure. The general groundwater flow direction in the vicinity of the landfill is to the north-northwest. The potentiometric surface in the area of well HL-94-3 suggests that groundwater flows to the west northwest (Figure 2-2); thus, well HL-94-3 is not considered to be upgradient or downgradient of the landfill. Well HL-94-3 has, therefore, been designated as a “cross-gradient” well.

Table 2-1 shows the groundwater velocities calculated for each of the monitoring wells sampled during the June 2010 sampling event. Slope was determined from the potentiometric contours shown in Figure 2-2. The hydraulic conductivities were obtained from the groundwater flow model inputs included in the report “Evaluation of Groundwater Extraction Remediation Alternative at the Helena Landfill” (Hydrometrics, 1999a). The porosity for each well was assumed to be 0.25. An average regional gradient of 0.0233 ft/ft was determined between monitoring well HL-06-1 and I-1. This yields an average regional velocity of 0.688 ft/day.

TABLE 2-1. GROUNDWATER VELOCITIES

Well	Hydraulic Conductivity (ft/day)	Slope (ft/ft)	Velocity (ft/day)
EPA-1	2.8	0.0285	0.319
HL-06-1	0.03	0.0380	0.00456
HL-10-1	20	0.222	17.8
HL-90-1	20	0.222	17.8
HL-90-2	5.6	0.0319	0.714
HL-90-3	0.03	0.0701	0.00841
HL-94-1R	2.8	0.0114	0.128
HL-94-2R	0.28	.0455	0.0509
HL-94-3	2.8	0.0154	0.172
HL-99-1	10	0.0224	0.897
HL-99-2	20	0.0559	4.47
HL-99-3	20	0.0638	5.10
I-1	20	0.0262	1.82
Infiltration Gallery	5.6	0.0228	0.588
MPC-1	2.8	0.0210	0.235
MPC-2	2.8	0.0275	0.308
MPC-5	2.8	0.0286	0.320

2.4 CURRENT ACTIVITIES

In a letter dated April 29, 2010, Martin Van Oort of MDEQ reviewed the Hydrometrics report, "Data Validation and Statistical Evaluation of December 2009 Groundwater Quality Data" and requested the installation of a new monitoring well near the location of well HL-90-1. This new well was to be drilled to approximately the same depth as the groundwater extraction wells and was to provide a more reliable compliance well. A new well, designated well HL-10-1, was drilled on May 25 of this year. This new well is located approximately 20 feet west of well HL-90-1 and was completed at a depth of 78.0 feet, the maximum depth at which the well could be completed. Full details on the installation and completion of this well were submitted to MDEQ in a letter dated July 15, 2010.

New modifications to Centennial Park, located over the old landfill, began in June of this year and will continue through the fall. Construction work includes the installation of fill material and some utilities, planting of new grass and trees, construction of new roads and trails, and the installation of a new automatic watering system and other park facilities. All modifications to the park were reviewed to ensure the integrity of the landfill cap would be maintained and that the final design would be even more protective of human health and the environment than the current design. All plans were submitted to MDEQ prior to construction. Every effort is being made to preserve the existing monitoring wells and the corrective measures previously implemented.

3. SUMMARY OF JUNE 2010 DATA VALIDATION REPORT

All fifteen monitoring wells around the landfill, seven domestic wells, one irrigation well and the infiltration gallery well were included in the June 2010 sampling event. Static water levels (SWL) were also obtained from two additional monitoring wells and one additional irrigation well. The June 2010 monitoring sites for the City of Helena Landfill include the following:

- Monitoring wells 82-3 (SWL only), EPA-1, EPA-4 (SWL only), HL-06-1, HL-10-1, HL-90-1, HL-90-2, HL-90-3, HL-94-1, HL-94-2, HL-94-3, HL-99-1, HL-99-2, HL-99-3, MPC-1, MPC-2, MPC-5;
- Irrigation wells I-1 (SWL only) and I-4;
- Domestic wells 5, 16, 40, 48, 52, 57, 62, 90; and
- The infiltration gallery.

The owner of well 90 could not be reached despite repeated attempts and thus this well could not be sampled during the June 2010 monitoring event. The June analytical parameters included metals, volatile organics, semi-volatile organics, halogenated organics, and major anions for all the monitoring wells except MPC-2 and volatile organics, semi-volatile organics, and halogenated organics for all remaining domestic and irrigation wells as specified in the approved sampling and analysis plan (Hydrometrics, 2008).

The water samples collected for the City of Helena Landfill in June 2010 have been validated by the Hydrometrics Data Validation Department in accordance with the project work plan, "Revised Sampling and Analysis Plan, City of Helena Landfill, Groundwater, Surface Water and Landfill Gas Monitoring Activities" (Hydrometrics, 2008). Lab and field quality control procedures were appropriate; quality control (QC) samples included a field duplicate, a D.I. blank, a trip blank, a rinseate blank, and standard internal laboratory QC samples. No parameters were reported as above the reporting limit in the D.I. blank, trip blank, or rinseate blank. However, the field duplicate pair collected at HL-90-3 exceeded the control limits for

4. STATISTICAL DATA EVALUATION AND COMPARISON

Four types of data evaluations were conducted using the June 2010 sample results for 14 of the 15 monitoring wells around the landfill; cross-gradient well HL-94-3 is evaluated separately. The infiltration gallery, irrigation well, and domestic wells are also evaluated separately. The four types of data evaluations conducted are:

1. Comparisons of applicable water quality criteria and upgradient (also called “background”) water quality with summary statistics of downgradient concentrations for June 2010 and all samples to date;
2. Inter-well prediction interval analysis;
3. Trend analysis; and
4. Temporal concentration plots.

The first three analyses include all those parameters for which results were reported above the detection limit in any of the monitoring wells for the June 2010 sampling event.

The fourth evaluation, temporal concentration plots, was performed for PCE and nitrate; the only constituents that currently exceed their regulatory limits in downgradient wells. Data from all wells which have historically shown PCE results above the detection limit of 0.001 mg/L and nitrate results above the MCL of 10 mg/L or with potentially increasing trends were evaluated.

4.1 DOWNGRADIANT WATER QUALITY COMPARISONS WITH CRITERIA AND UPGRADIANT WATER QUALITY

The following conclusions are derived from the June 2010 data and summary statistics in Tables 4-1, 4-2, and 4-3:

- (a) For the June 2010 sampling event (Tables 4-1 and 4-2), the following parameters were detected only in background (also called upgradient) wells: arsenic, iron, selenium,

**TABLE 4-1. SUMMARY OF PARAMETER CONCENTRATIONS IN LANDFILL MONITORING WELLS
FOR THE JUNE 2010 MONITORING EVENT**

Parameter	Downgradient Wells										Upgradient Wells				Cross-Gradient Well	MCL ⁽¹⁾
	HL-10-1	HL-90-1	HL-90-2	HL-90-3	MPC-1	MPC-2	EPA-1	HL-99-1	HL-99-2	HL-99-3	HL-06-1	MPC-5	HL-94-1R	HL-94-2R	HL-94-3	
pH (s.u.)	7.6	7.9	7.9	7.9	8.0	NM	7.4	7.6	7.8	7.8	7.7	7.5	7.9	8.1	8.1	NA
Specific Conductance (µmhos/cm)	1320	1090	692	1290	1160	NM	1520	1230	864	950	1170	2800	1000	968	1030	NA
Sulfate	140	130	45	180	180	NM	85	150	120	150	110	690	180	71	160	NA
Chloride	86	59	22	54	53	NM	130	61	40	45	34	18	42	39	82	NA
Nitrate+Nitrite as N	9.4	9.0	0.55	10.1	12.2	NM	3.51	9.0	6.2	8.5	2.47	19.2	4.1	6.8	12.6	10
Arsenic (Dissolved)	<0.005	<0.005	<0.005	<0.005	<0.005	NM	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.011	<0.005	0.010
Iron (Dissolved)	<0.03	<0.03	<0.03	<0.03	<0.03	NM	<0.03	<0.03	<0.03	<0.03	<0.03	1.13	<0.03	<0.03	0.03	0.3 ⁽²⁾
Selenium (Dissolved)	<0.005	<0.005	<0.005	<0.005	<0.005	NM	<0.005	<0.005	<0.005	<0.005	<0.005	0.006	<0.005	<0.005	<0.005	0.05
Zinc (Dissolved)	<0.01	<0.01	<0.01	<0.01	<0.01	NM	<0.01	0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	2
1,1,1-Trichloroethane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0039	<0.001	<0.001	<0.001	<0.001	0.2
1,1-Dichloroethane	0.0023	0.0017	<0.001	<0.001	0.0029	<0.001	<0.001	<0.001	0.0015	0.0029	<0.001	<0.001	<0.001	<0.001	<0.001	NA
Benzene	<0.001	0.0021	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0057	<0.001	<0.001	<0.001	0.005
Bromodichloromethane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0018	<0.001	<0.001	0.010
Chloroform	<0.001	0.0011	<0.001	0.0074	0.0023	<0.001	<0.001	0.0031	0.0016	0.0026	<0.010	<0.001	0.015	0.0037	0.0048	0.07
Cis-1,2-Dichloroethene	0.0019	<0.001	<0.001	<0.001	0.0021	<0.001	<0.001	0.0020	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.07
Dichlorodifluoromethane	0.0015	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0012	0.0017	<0.001	<0.001	<0.001	<0.001	<0.001	1
Total Xylene	<0.001	0.0021	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0059	<0.001	<0.001	<0.001	10
Tetrachloroethene (PCE)	0.0060	0.0021	<0.001	<0.001	0.0089	<0.001	0.0013	0.0031	0.0033	0.0052	<0.001	<0.001	<0.001	<0.001	<0.001	0.005
Trichloroethene (TCE)	0.0015	<0.001	<0.001	<0.001	0.0022	<0.001	<0.001	<0.001	<0.001	0.0011	<0.001	<0.001	<0.001	<0.001	<0.001	0.005
Trichlorofluoromethane	<0.001	<0.001	<0.001	<0.001	0.0011	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	10
Cyanide (Total)	<0.005	<0.005	<0.005	<0.005	0.045	NM	<0.005	<0.005	<0.005	0.026	<0.005	6.2	<0.005	<0.005	0.011	0.2
Chemical Oxygen Demand (COD)	<1	<1	2	1	1	NM	6	4	2	2	<1	27	2	1	<1	NA

Concentrations are in mg/L, except as indicated.

NM = not measured

(1) Primary Maximum Contaminant Levels promulgated under the Safe Drinking Water Act for protection of public drinking water supplies.

NA indicates no MCL has been promulgated.

(2) Secondary Maximum Contaminant Level based on aesthetic properties such as taste, odor, and staining.

Values in **bold** exceed the MCL.

**TABLE 4-2. COMPARISON OF DOWNGRADIENT CONCENTRATIONS WITH BACKGROUND CONCENTRATIONS
AND MCLs FOR THE JUNE 2010 SAMPLING EVENT**

Parameter	June 2010 Downgradient Well Concentrations (mg/L) ⁽¹⁾						Comparison Values (mg/L)				
	D.F. ⁽³⁾	Min.	Mean ⁽⁴⁾	Median	Max.	Max. Location	Background / Upgradient Wells ⁽²⁾				MCL ⁽⁵⁾
							D.F. ⁽³⁾	Mean ⁽⁴⁾	Median	Max.	
pH (s.u.)	9/9	7.4	7.77	7.8	8.0	MPC-1	4/4	7.80	7.7	8.1	NA
Specific Conductance (µmhos/cm)	9/9	692	1124.0	1160	1520	HL-10-01	4/4	1484.5	1000	2800	NA
Sulfate	9/9	45	131.1	140	180	HL-90-3	4/4	262.8	110	690	NA
Chloride	9/9	22	61.1	54	130	HL-10-01	4/4	33.3	34	42	NA
Nitrate+Nitrite as N	9/9	0.55	7.61	9.0	12.2	MPC-1	4/4	8.14	4.1	19.2	10
Arsenic (Dissolved)	0/9	<0.005	<0.005	<0.005	<0.005	NA	1/4	0.0065	<0.005	0.011	0.010
Iron (Dissolved)	0/9	<0.03	<0.03	<0.03	<0.03	NA	1/4	0.305	<0.03	1.13	0.3 ⁽⁶⁾
Selenium (Dissolved)	0/9	<0.005	<0.005	<0.005	<0.005	NA	1/4	0.0053	<0.005	0.0060	0.05
Zinc (Dissolved)	1/9	<0.01	<u>0.010</u>	<0.01	<u>0.010</u>	MPC-1	0/4	<0.01	<0.01	<0.01	2
1,1,1-Trichloroethane	0/10	<0.001	<0.001	<0.001	<0.001	NA	1/4	0.0017	<0.001	0.0039	0.2
1,1-Dichloroethane	5/10	<0.001	<u>0.0016</u>	<u>0.0013</u>	<u>0.0029</u>	HL-99-3	0/4	<0.001	<0.001	<0.001	NA
Benzene	0/10	<0.001	<0.001	<0.001	<0.001	NA	1/4	0.0022	<0.001	0.0057	0.005
Bromodichloromethane	0/10	<0.001	<0.001	<0.001	<0.001	NA	1/4	0.0012	<0.001	0.0018	0.010
Chloroform	6/10	<0.001	0.0022	0.0014	0.0074	HL-90-3	2/4	0.0052	<0.001	0.015	0.07
Cis-1,2-Dichloroethene	3/10	<0.001	<u>0.0013</u>	<0.001	<u>0.0021</u>	MPC-1	0/4	<0.001	<0.001	<0.001	0.07
Dichlorodifluoromethane	3/10	<0.001	<u>0.0011</u>	<0.001	<u>0.0017</u>	HL-99-3	0/4	<0.001	<0.001	<0.001	1
Total Xylene	0/10	<0.001	<0.001	<0.001	<0.001	NA	1/4	0.0022	<0.001	0.0059	10
Tetrachloroethene (PCE)	6/10	<0.001	<u>0.0033</u>	<u>0.0026</u>	0.0089	MPC-1	0/4	<0.001	<0.001	<0.001	0.005
Trichloroethene (TCE)	3/10	<0.001	<u>0.0012</u>	<0.001	<u>0.0022</u>	MPC-1	0/4	<0.001	<0.001	<0.001	0.005
Trichlorofluoromethane	1/10	<0.001	<u>0.0010</u>	<0.001	<u>0.0011</u>	MPC-1	0/4	<0.001	<0.001	<0.001	10
Cyanide (Total)	2/9	<0.005	0.012	<0.005	0.045	MPC-1	1/4	1.55	<0.005	6.2	0.2
Chemical Oxygen Demand (COD)	6/9	<1	2.22	2	6.0	HL-99-1	3/4	7.8	1	27	NA

(1) Downgradient wells are: HL-10-1, HL-90-1, HL-90-2, HL-90-3, MPC-1, MPC-2, EPA-1, HL-99-1, HL-99-2, HL-99-3.

(2) Background / Upgradient wells are: HL-06-1, MPC-5, HL-94-1, HL-94-2.

(3) Detection frequency (D.F.), i.e. the number of detections over the total number of samples analyzed for that parameter.

(4) Means calculated using the detection limit for non-detected sample results.

(5) Primary Maximum Contaminant Levels promulgated under the Safe Drinking Water Act for protection of public drinking water supplies.

NA indicates no MCL has been promulgated.

(6) Secondary Maximum Contaminant Level based on aesthetic properties such as taste, odor, and staining.

Values in **bold** exceed the MCL. Underlined values exceed the maximum background/upgradient concentration.

**TABLE 4-3. COMPARISON OF DOWNGRAIDENT CONCENTRATIONS WITH BACKGROUND CONCENTRATIONS
AND MCLs FOR ALL SAMPLING EVENTS TO DATE**

Parameter	Period of Record Downgradient Well Concentrations (mg/L) ⁽¹⁾						Comparison Values (mg/L)				
	D.F. ⁽³⁾	Min.	Mean ⁽⁴⁾	Median	Max.	Max. Location	Background / Upgradient Wells ⁽²⁾				MCL ⁽⁵⁾
							D.F. ⁽³⁾	Mean ⁽⁴⁾	Median	Max.	
pH (s.u.)	205/205	6.9	7.49	7.5	8.1	HL-90-2	119/119	7.46	7.5	8.1	NA
Specific Conductance (µmhos/cm)	196/196	632	955.1	978	1320	HL-10-01	115/115	1381.1	1000	4170	NA
Sulfate	205/205	15	128.1	130	232	MPC-1	119/119	278.3	97	1980	NA
Chloride	205/205	10	42.5	40	94	HL-90-1	118/119	46.4	27	250	NA
Nitrate+Nitrite as N	185/187	0.05	7.37	7.84	16.2	MPC-1	114/114	11.25	6.9	73	10
Arsenic (Dissolved)	4/204	<0.005	0.0053	<0.005	0.028	MPC-2	47/122	0.0069	<0.005	0.1	0.010
Iron (Dissolved)	46/205	<0.03	0.0867	<0.03	1.69	MPC-1	42/119	0.306	<0.03	3.14	0.3 ⁽⁶⁾
Selenium (Dissolved)	5/204	<0.005	0.0050	<0.005	0.006	HL-90-3	36/122	0.0057	<0.005	0.027	0.05
Zinc (Dissolved)	27/189	<0.01	0.0143	<0.01	<u>0.15</u>	HL-90-2	14/117	0.011	<0.01	0.10	2
1,1,1-Trichloroethane	54/320	<0.001	0.0012	<0.001	<u>0.0074</u>	HL-90-1	12/126	0.0012	<0.001	0.0057	0.2
1,1-Dichloroethane	204/320	<0.001	<u>0.0020</u>	<u>0.0015</u>	<u>0.0073</u>	MPC-1	0/126	<0.001	<0.001	<0.001	NA
Benzene	1/320	<0.001	0.0010	<0.001	0.0029	HL-90-2	26/126	0.0048	<0.001	0.077	0.005
Bromodichloromethane	0/320	<0.001	<0.001	<0.001	0.002	HL-99-1	9/126	0.0011	<0.001	0.0048	0.010
Chloroform	240/320	<0.001	0.0024	0.0021	0.013	HL-90-3	97/126	0.0050	0.0027	0.037	0.07
Cis-1,2-Dichloroethene	79/302	<0.001	<u>0.0012</u>	<0.001	<u>0.0036</u>	MPC-1	0/121	<0.001	<0.001	<0.001	0.07
Dichlorodifluoromethane	134/320	<0.001	<u>0.0016</u>	<0.001	<u>0.015</u>	HL-90-1	0/126	<0.001	<0.001	<0.001	1
Total Xylene	1/115	<0.001	0.0010	<0.001	0.002	MPC-2	9/46	0.0049	<0.001	0.053	10
Tetrachloroethene (PCE)	218/320	<0.001	0.0053	<u>0.0044</u>	0.024	HL-99-3	0/126	<0.001	<0.001	<0.001	0.005
Trichloroethene (TCE)	140/320	<0.001	<u>0.0013</u>	<0.001	<u>0.0038</u>	MPC-1	0/126	<0.001	<0.001	<0.001	0.005
Trichlorofluoromethane	49/320	<0.001	<u>0.0011</u>	<0.001	<u>0.0044</u>	HL-99-3	0/126	<0.001	<0.001	<0.001	10
Cyanide (Total)	73/210	<0.005	0.0138	<0.005	0.151	MPC-1	27/126	0.99	<0.005	10.9	0.2
Chemical Oxygen Demand (COD)	129/203	0.3	3.52	2	25	HL-99-3	96/120	12.7	8	75	NA

(1) Downgradient wells are: HL-10-1, HL-90-1, HL-90-2, HL-90-3, MPC-1, MPC-2, EPA-1, HL-99-1, HL-99-2, HL-99-3.

(2) Background / Upgradient wells are: 83-6, HL-06-1, MPC-5, HL-94-1, HL-94-2.

(3) Detection frequency (D.F.), i.e. the number of detections over the total number of samples analyzed for that parameter.

(4) Means calculated using the detection limit for non-detected sample results.

(5) Primary Maximum Contaminant Levels promulgated under the Safe Drinking Water Act for protection of public drinking water supplies.

NA indicates no MCL has been promulgated.

(6) Secondary Maximum Contaminant Level based on aesthetic properties such as taste, odor, and staining.

Values in **bold** exceed the MCL. Underlined values exceed the maximum background/upgradient concentration.

1,1,1-trichloroethane, benzene, bromodichloromethane, and total xylenes. Parameters detected in only downgradient wells include: zinc, 1,1-dichloroethane, cis-1,2-dichloroethene, dichlorodifluoromethane, tetrachloroethene (PCE), trichloroethene (TCE), and trichlorofluoromethane.

- (b) The parameter historically detected only in background wells (Table 4-3) is bromodichloromethane. Parameters historically detected only in downgradient wells include: 1,1-dichloroethane, cis-1,2-dichloroethene, dichlorodifluoromethane, PCE, TCE, and tri-chlorofluoromethane.
- (c) Nitrate, arsenic, iron, benzene, PCE and cyanide were reported at concentrations exceeding MCL criteria in the June 2010 sampling event (Tables 4-1 and 4-2). The MCL for arsenic was exceeded in a single upgradient well (HL-94-2R); the MCLs for benzene and cyanide were exceeded in a single upgradient well (MPC-5); the MCL for PCE was exceeded in three downgradient wells (HL-10-1, MPC-1 and HL-99-3); nitrate exceeded its MCL in two downgradient wells (HL-90-3 and MPC-1), one upgradient well (MPC-5), and cross-gradient well HL-94-3; the secondary MCL (based on aesthetic properties rather than human health standards) for iron was exceeded in a single upgradient well (MPC-5).
- (d) Historically in these wells, nitrate, arsenic, iron, benzene, PCE, and cyanide have been reported at concentrations exceeding MCL criteria (Table 4-3). The MCL for PCE has been exceeded in only downgradient wells; nitrate, arsenic and iron have exceeded their MCLs in both upgradient and downgradient wells; and the MCLs for benzene and cyanide have been exceeded in only upgradient wells. The June 2010 data is generally consistent with these trends.
- (g) Nitrate was detected in all of the June 2010 samples. The MCL of 10.0 mg/L was exceeded in one sample collected in upgradient well (MPC-5) and in two samples collected from downgradient wells (HL-90-3 and MPC-1). Monitoring well MPC-5 showed an increasing trend from 1998 through 2005 reaching a maximum of 73.0 mg/L. Since then, there has been a decrease in the nitrate concentration in this well and is currently at a level of 19.2 mg/L. Discussions with MPC representatives revealed that an attempt to remediate cyanide (from a historic coal gasification plant

that was operated just east of the landfill) through oxidation may have inadvertently increased nitrate concentration in area groundwater. This pilot program was shut down when these adverse affects became apparent. However, nitrate levels in downgradient wells have slowly been increasing since that time.

- (i) Metals and arsenic concentrations in groundwater samples have historically been low (typically below laboratory detection limits). Arsenic was detected only in upgradient well HL-94-2R; iron and selenium were only detected in upgradient well MPC-5; and zinc was detected only in downgradient well HL-99-1 during June 2010 monitoring (Table 4-1). The detected arsenic and metal concentrations were all at or near their detection limits except for arsenic in upgradient well HL-94-2R (0.011 mg/L) compared to a detection limit of 0.005 mg/L and iron in upgradient well MPC-5 (1.02 mg/L) compared to a detection limit of 0.03 mg/L. Arsenic exceeded the MCL of 0.01 mg/L in HL-94-2R. Iron has historically fluctuated at HL-94-2 with concentrations ranging from <0.005 mg/L to 0.011 mg/L (based on data collected from April 1994 through June 2010). Iron exceeded the secondary MCL of 0.3 mg/L (based on aesthetic properties such as taste, odor and staining rather than human health standards) in MPC-5. Iron has historically fluctuated at MPC-5 with concentrations ranging from approximately 0.2 mg/L to 4 mg/L (based on data collected from December 1995 through June 2010).
- (j) During the June 2010 sampling event, several volatile organic compounds (VOCs) were detected in samples from downgradient wells, but not in samples from background wells (1,1-dichloroethane, cis-1,2-dichloroethene, dichlorodifluoromethane, PCE, TCE, and trichlorofluoromethane). PCE was the only VOC to exceed its MCL in downgradient wells (HL-10-1, MPC-1 and HL-99-3). 1,1,1-trichloroethane, benzene, bromodichloromethane and total xylenes were detected only in background wells; benzene was the only VOC to exceed its MCL in upgradient wells (MPC-5). Chloroform was the only VOC detected in samples from both downgradient and background wells. All detections of chloroform were well below the MCL of 0.07 mg/L.

- (k) Well HL-10-1 was installed in May of this year immediately adjacent to compliance well HL-90-1, but completed approximately 20 feet deeper. The concentrations of SC, chloride, cis-1,2-dichloroethene, dichlorofluoromethane, PCE and TCE in HL-10-1 were significantly greater than in HL-90-1 during the June 2010 sampling event, as would be expected with heavier chlorinated compounds (Table 4-1). PCE was the only compound to exceed its MCL.
- (h) Cyanide was detected in two downgradient wells (MPC-1 and HL-99-3) and one upgradient well (MPC-5) during the June 2010 sampling event. Both the downgradient detections were well below the MCL of 0.2 mg/L, but upgradient well MPC-5 (6.2 mg/L) exceeded the MCL. Previous sampling events have shown that cyanide is present at concentrations ranging from approximately 0.77 to 11 mg/L (based on data collected from June 1995 through June 2010) in upgradient well MPC-5. Historically, downgradient detections of cyanide have been well below the MCL indicating that elevated cyanide levels are not attributable to the Helena Landfill (Table 4-3). As noted previously, a coal gasification plant was historically operated east of the landfill site and could be a source of residual cyanide in groundwater upgradient of the landfill.

4.2 INTER-WELL PREDICTION INTERVAL ANALYSIS

An inter-well prediction interval analysis was used to test for statistically significant differences between background and compliance well concentrations for selected parameters (those above the detection limit in any of the monitoring wells for the June 2010 sampling event). Combining all historical data for the background wells, the Shapiro-Francia Test of Normality was performed for each parameter to determine the distribution of the background data. Inter-well parametric prediction intervals were used when the background data were normally or ln-normally distributed. In cases where the background data were not normally or ln-normally distributed, a non-parametric prediction limit was used. All non-detect values were evaluated at one half the detection limit. Results of the prediction interval test are summarized in Table 4-4. Documentation for each of these statistical tests used is included in Appendix B of this report.

TABLE 4-4. RESULTS OF INTER-WELL PREDICTION INTERVAL TESTS

Parameter	Background Wells		Downgradient Wells									
	Distribution ⁽¹⁾	Prediction Limit ⁽²⁾	HL-10-1	HL-90-1	HL-90-2	HL-90-3	MPC-1	MPC-2	EPA-1	HL-99-1	HL-99-2	HL-99-3
pH (s.u.)	Non-Norm	6.9-7.9	7.6	7.9	7.9	7.9	8.0	NM	7.4	7.6	7.8	7.8
Specific Conductance (µmhos/cm)	Non-Norm	4055	1320	1090	692	1290	1160	NM	1520	1230	864	950
Sulfate	Non-Norm	1768	140	130	45	180	180	NM	85	150	120	150
Chloride	Non-Norm	191	86	59	22	54	53	NM	130	61	40	45
Nitrate+Nitrite as N	Non-Norm	69.2	9.4	9.0	0.55	10.1	12.2	NM	3.51	9.0	6.2	8.5
Arsenic (Dissolved)	Non-Norm	0.0315	<0.005	<0.005	<0.005	<0.005	<0.005	NM	<0.005	<0.005	<0.005	<0.005
Iron (Dissolved)	Non-Norm	2.91	<0.03	<0.03	<0.03	<0.03	<0.03	NM	<0.03	<0.03	<0.03	<0.03
Selenium (Dissolved)	Non-Norm	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	NM	<0.005	<0.005	<0.005	<0.005
Zinc (Dissolved)	Non-Norm	0.020	<0.01	<0.01	<0.01	<0.01	<0.01	NM	<0.01	0.010	<0.01	<0.01
1,1,1-Trichloroethane	Non-Norm	0.0053	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloroethane	ND	0.001	0.0023	0.0017	<0.001	<0.001	0.0029	<0.001	<0.001	<0.001	0.0015	0.0029
Benzene	Non-Norm	0.065	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bromodichloromethane	Non-Norm	0.0041	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chloroform	Non-Norm	0.036	<0.001	0.0011	<0.001	0.0074	0.0023	<0.001	<0.001	0.0031	0.0016	0.0026
Cis-1,2-Dichloroethene	ND	0.001	0.0019	<0.001	<0.001	<0.001	0.0021	<0.001	<0.001	0.0020	<0.010	<0.001
Dichlorodifluoromethane	ND	0.001	0.0015	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0012	0.0017
Total Xylene	Non-Norm	0.049	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tetrachloroethene (PCE)	ND	0.001	0.006	0.0021	<0.001	<0.001	0.0089	<0.001	0.0013	0.0031	0.0033	0.0052
Trichloroethene (TCE)	ND	0.001	0.0015	<0.001	<0.001	<0.001	0.0022	<0.001	<0.001	<0.001	<0.001	0.0011
Trichlorofluoromethane	ND	0.001	<0.001	<0.001	<0.001	<0.001	0.0011	<0.001	<0.001	<0.001	<0.001	<0.001
Cyanide (Total)	Non-Norm	10.4	<0.005	<0.005	<0.005	<0.005	0.045	NM	<0.005	<0.005	<0.005	0.026
Chemical Oxygen Demand (COD)	Non-Norm	64.6	<1	<1	2	1	1	NM	6	4	2	2

(1) Normality was calculated using the Shapiro-Francia test.

Norm (X%) = data normally distributed at X% level of significance.

ln-Norm (X%) = data ln-normally distributed at X% level of significance.

Non-Norm = data not normally or ln-normally distributed at 95% or 99% level of significance.

ND = all background data below detection limits. Value shown is the detection limit.

(2) Prediction limits calculated as follows:

Normal or ln-normal distribution: parametric prediction interval (99% one-sided, two-sided for pH)

Non-normal distribution: non-parametric prediction interval (99% one-sided, two-sided for pH)

ND: any detectable concentrations in compliance wells are considered significant.

Bold values indicate statistically significant results.

NA - not analyzed

As shown on Table 4-4, 1,1-dichloroethane, cis-1,2-dichloroethane, dichlorodifluoromethane, PCE, TCE, and trichlorofluoromethane have statistically greater concentrations in downgradient wells than upgradient wells.

4.3 TREND ANALYSIS

In addition to evaluating the chemical concentrations in upgradient and downgradient wells around the landfill for the June 2010 sampling event, it is also important to evaluate concentration trends of key constituents over time. Using the Mann-Kendall test, statistical testing for trends was performed for each downgradient exceedance of its respective inter-well prediction interval as discussed in Section 4.2. All non-detect values were evaluated as zero to prevent the detection of false trends when parameters are detected at concentrations less than the reporting limit or when the reporting limits have changed over time. This test was not performed for well HL-10-1 as there is only a single sample result. The results of these analyses are summarized in Table 4-5. Documentation for these statistical tests is included in Appendix B of this report.

TABLE 4-5. RESULTS OF MANN-KENDALL TREND ANALYSES

Parameter	HL-90-1	MPC-1	EPA-1	HL-99-1	HL-99-2	HL-99-3
1,1-Dichloroethane	Decreasing	Decreasing			Increasing	No Trend
Cis-1,2-Dichloroethane		Increasing		Increasing		
Dichlorodifluoromethane					No Trend	Decreasing
Tetrachloroethene (PCE)	Decreasing	No Trend	Decreasing	Decreasing	No Trend	Decreasing
Trichloroethene (TCE)		No Trend				No Trend
Trichlorofluoromethane		No Trend				

*Grayed boxes did not have downgradient exceedances of the respective inter-well prediction interval and therefore a trend analysis was not performed.

Cis-1,2-dichloroethane is showing increasing trends in MPC-1 and HL-99-1; according to National Primary Drinking Water Regulations, cis-1,2-dichloroethane is formed as a breakdown product from the reductive dehalogenation of the common industrial solvents TCE and PCE. Dichlorodifluoromethane and PCE are showing decreasing trends in downgradient wells. 1,1-Dichloroethane is showing increasing and decreasing trends in

downgradient wells; this compound is a breakdown product of 1,1,1-trichloroethane, historically found primarily in wells upgradient of the Helena landfill.

4.4 TEMPORAL CONCENTRATION PLOTS

This report focuses on concentration trends for PCE and nitrate because they are the only constituents currently exceeding their MCLs in downgradient monitoring wells. PCE was also the focus of the Corrective Measures Assessment for the landfill (Hydrometrics, 1995).

In an attempt to reduce concentrations of PCE in compliance well HL-90-1, the City installed a groundwater extraction system in the spring of 2000 (Hydrometrics, 1999b). This treatment system involves pumping wells HL-99-1, HL-99-2 and HL-99-3 to intercept PCE leaving the landfill, and treating the water to remove VOCs prior to land application on Bill Roberts Golf Course. These wells have been included in groundwater monitoring events along with compliance well HL-90-1 to evaluate the progress of this new groundwater extraction system.

Trends in PCE concentrations over time for the past ten years for selected monitoring wells are shown on Figure 4-1. PCE concentrations exceeded the MCL value of 0.005 mg/L in monitoring wells HL-10-1, MPC-1 and HL-99-3 for June 2010. Well HL-10-1 is not shown on the trend plot since only a single data point is available.

Historically, the concentration of PCE in well MPC-1 (now 0.0089 mg/L) has fluctuated between 0.0032 mg/L and 0.017 mg/L based on data collected between May 1992 and June 2010 and according to the trend analysis discussed in the previous section, is showing neither an increasing or a decreasing trend. The PCE concentrations in pumping wells HL-99-1, HL-99-2 and HL-99-3 have shown seasonal fluctuations and decreasing trends in HL-99-1 and HL-99-3 since their installation in 1999. Concentrations in well EPA-1 have decreased significantly since monitoring began (>90 ppb) and have been below the MCL for the last ten years. Compliance well HL-90-1 has shown definite improvement since the installation of the groundwater extraction system in June 2000, averaging 0.0146 mg/L before the extraction

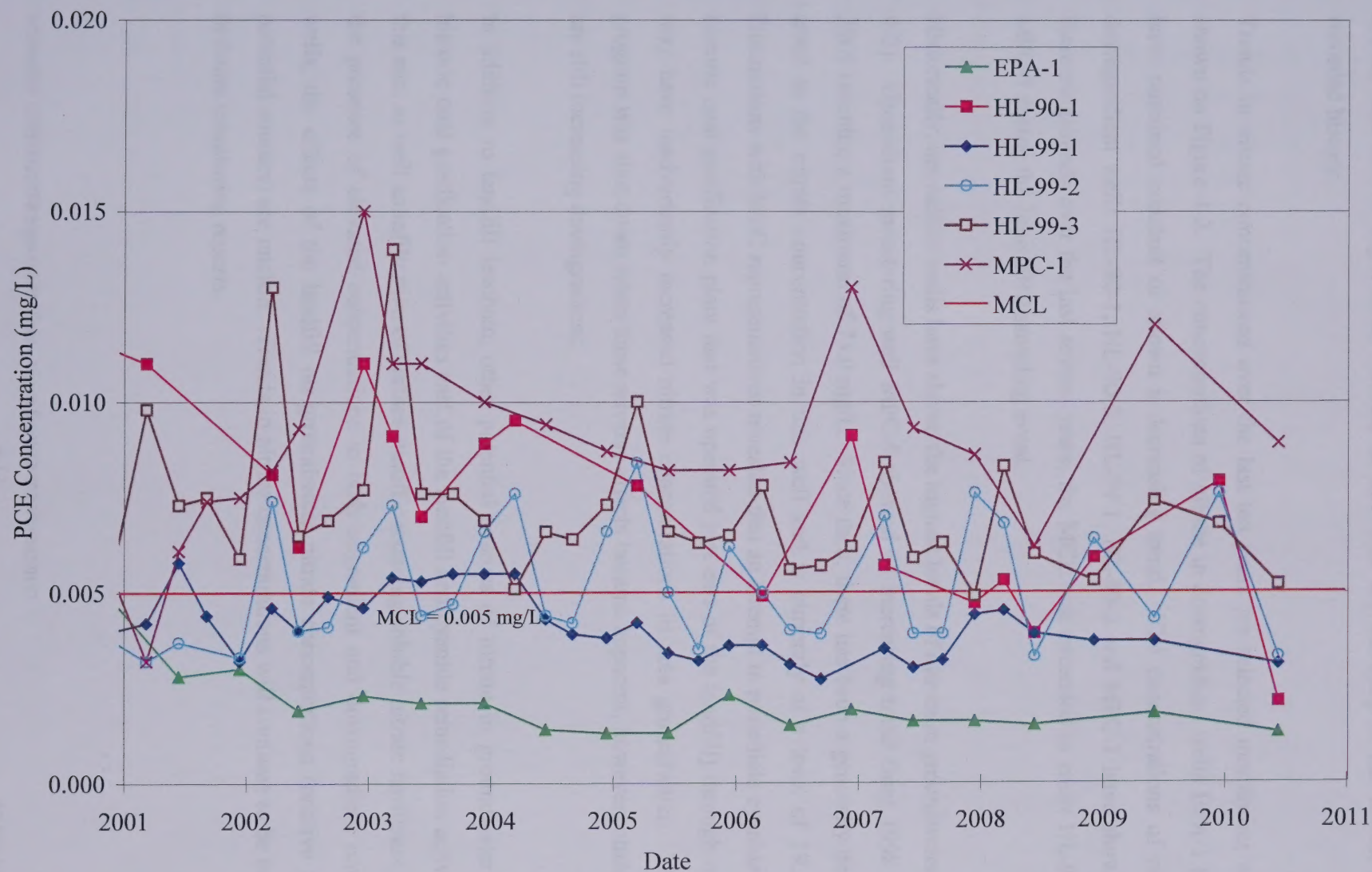


Figure 4-1. Temporal Trends in Tetrachloroethene Concentrations at Selected Monitoring Wells

system and 0.0074 mg/L after. Levels in this well are currently at the lowest level in recorded history.

Trends in nitrate concentrations over the last ten years for selected monitoring wells are shown on Figure 4-2. The concentrations of nitrate in downgradient wells EPA-1 HL-99-2 have remained constant or shown a decreasing trend. The concentrations of nitrate in downgradient wells HL-90-1, HL-90-3, HL-99-1, HL-99-3 and MPC-1 have shown slight increasing trends over the last several years; the MCL was exceeded in wells HL-90-3 and MPC-1 during the June 2010 sampling event.

Historically, upgradient wells have shown the highest levels of nitrate in groundwater (Figure 4-2). Upgradient monitoring well MPC-5 showed an increasing trend from 1998 through 2005 reaching a maximum of 73.0 mg/L. Since then, there has been a generally decreasing trend in the nitrate concentration in this well and is currently at a level of 19.2 mg/L. Discussions with MPC representatives revealed that an attempt to remediate cyanide (from a historic coal gasification plant that was operated just east of the landfill) through oxidation may have inadvertently increased nitrate concentrations in area groundwater. This pilot program was shut down when these adverse affects became apparent; however, nitrate levels are still increasing downgradient.

In addition to landfill leachate, other potential sources of nitrate in groundwater include historic coal gasification activities east of the landfill and cyanide remediation activities for this site, as well as infiltration of surface runoff containing soluble nitrate fertilizers. Due to the presence of elevated concentrations in both upgradient and downgradient monitoring wells, the effects of the landfill on groundwater nitrate concentrations (relative to other potential sources) are unclear. Trends in nitrate concentrations will continue to be evaluated in future monitoring reports.

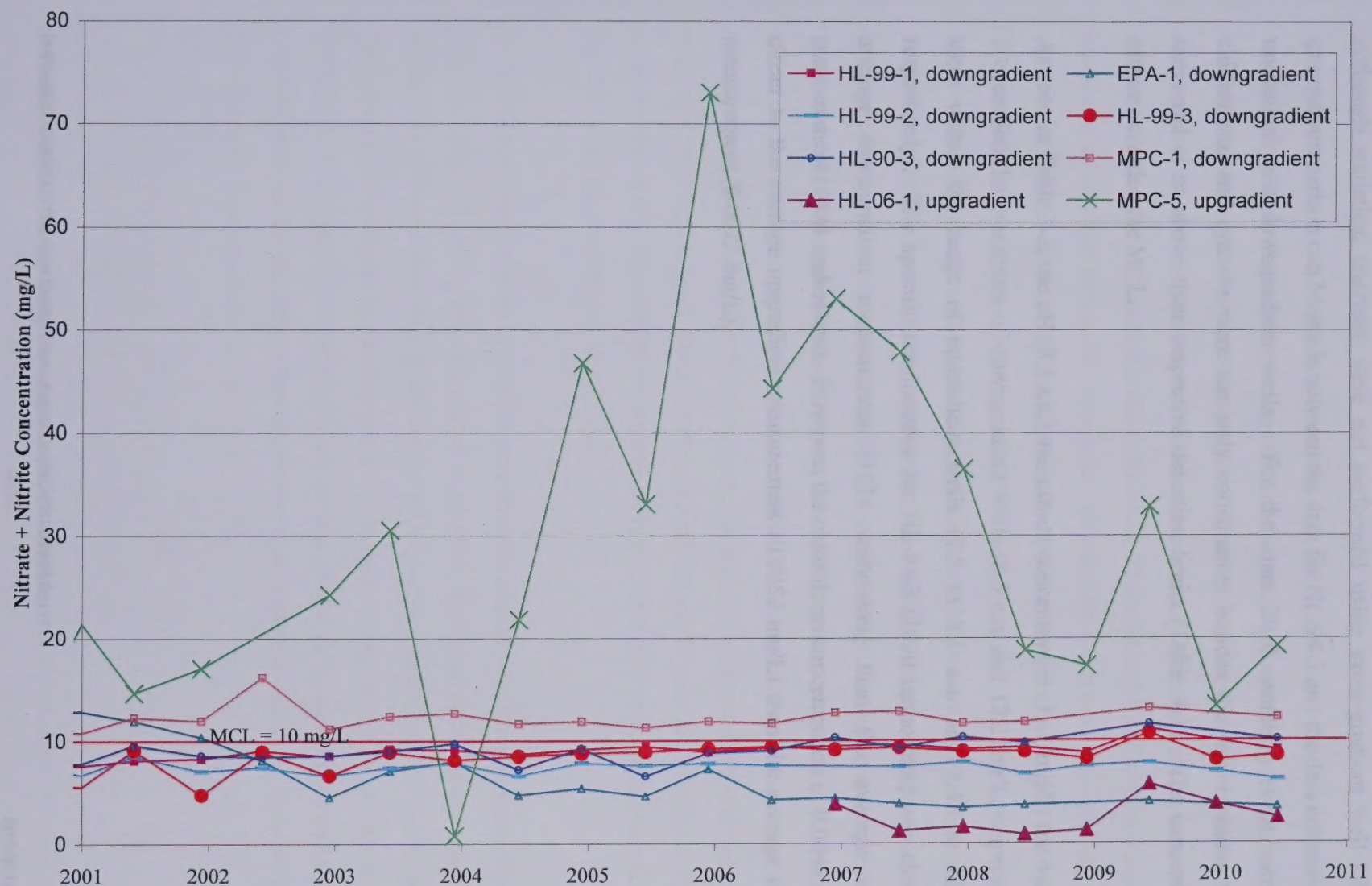


Figure 4-2. Temporal Trends in Nitrate Concentrations at Selected Monitoring Wells

4.5 CROSS-GRADIENT DATA EVALUATION

Although statistical analyses were not performed using cross-gradient well HL-94-3, a general comparison can be made between the data for HL-94-3 and the data collected for both upgradient and downgradient wells. For the June 2010 sampling event, nitrate, iron, chloroform, and cyanide were the only constituents besides the major anions that were measured at or above their respective detection limits (Table 4-1). The concentration of nitrate exceeded the MCL.

As seen in Table 3-2, the pH (8.1 s.u.) and nitrate concentration (12.6 mg/L) for well HL-94-3 exceeded the maximum of downgradient wells (8.0 s.u. and 12.2 mg/L, respectively) but were within the range of upgradient wells (7.5 to 8.1 s.u. and 2.47 to 19.2 mg/L, respectively). The specific conductance for HL-94-3 (1030 umhos/cm) was closer to the average downgradient measurement (1124 umhos/cm) than the average upgradient measurement (1484 umhos/cm). However, the chloroform concentration of 0.0048 mg/L was closer to the average upgradient measurement (0.0052 mg/L) than the average upgradient measurement (0.0022 mg/L),

5. IRRIGATION WELL AND DOMESTIC WELL DATA EVALUATION

One irrigation well, the infiltration gallery and seven domestic wells were also sampled during the June 2010 sampling event. The infiltration gallery and well 62 had no VOCs reported above the detection limits. For wells 5, 16, 40, 48, 52 and 57, the only concentrations of VOCs reported above the detection limit were for chloroform and tetrachloroethene; all detections were below their respective MCLs. Irrigation well I-4 had measurable concentrations of 1,1-dichloroethane, chloroform, cis-1,2-dichloroethene, dichlorodifluoromethane, PCE and TCE. Only the concentration of PCE (0.0056 mg/L) exceeded its MCL (0.005 mg/L). Trends in PCE concentrations over the last ten years for the sampled domestic and irrigation wells are shown on Figure 5-1. Using the Mann-Kendall test, PCE results in I-4 are showing a statistically significant downward trend (test results are included in Appendix B). All of these wells are used only for irrigation and all homeowners of these domestic wells have been connected to the City water supply.



Figure 5-1. Temporal Trends in PCE Concentrations in Domestic and Irrigation Wells

6. SUMMARY AND CONCLUSIONS

This statistical evaluation of the June 2010 sample results indicated that 1,1-dichloroethene, cis-1,2-dichloroethene, dichlorodifluoromethane, PCE, TCE, and trichlorofluoromethane were detected in downgradient wells at levels statistically greater than upgradient wells. PCE and nitrate were the only groundwater constituents that exceeded the primary MCL (federal drinking water standard) in one or more downgradient wells. The MCLs for nitrate, benzene, and cyanide and the secondary MCL for iron were exceeded in upgradient well MPC-5 and the MCL for arsenic was exceeded in upgradient well HL-94-2R.

Nitrate exceeded the MCL of 10.0 mg/L in one sample collected in upgradient well (MPC-5) and in two samples collected from downgradient wells (HL-90-3 and MPC-1). Historically, concentrations of nitrate in upgradient wells have far exceeded concentrations in downgradient wells. Due to the presence of elevated concentrations in both upgradient and downgradient monitoring wells, the effects of the landfill on groundwater nitrate concentrations (relative to other potential sources such as the historic industrial area east of the landfill and commonly used nitrate fertilizers) are unclear. Monitoring of groundwater nitrate concentrations will continue in future semiannual monitoring events, allowing further evaluation of upgradient and downgradient concentration trends.

To address the elevated PCE concentrations in compliance well HL-90-1, a groundwater extraction system was installed and began operation in June 2000. Groundwater is being pumped from three wells (HL-99-1, HL-99-2 and HL-99-3) located to intercept PCE leaving the landfill, and treated to remove VOCs prior to land application. These wells are included in the semiannual groundwater monitoring events to evaluate the progress of the new system. Statistical evaluations of PCE concentrations in wells EPA-1, HL-90-1 HL-99-1 and HL-99-3 show a decreasing trend, and the concentration in HL-90-1 is currently the lowest in recorded history at 0.0021 mg/L.

PCE exceeded the federal MCL in downgradient wells HL-10-1, MPC-1 and HL-99-3. Well HL-10-1 was installed in May of this year immediately adjacent to compliance well HL-90-1. Well HL-10-1 was completed approximately 20 feet deeper than well HL-90-1. The concentration of PCE in well HL-10-1 was greater than in well HL-90-1 (0.006 mg/L compared to 0.0021 mg/L) during the June 2010 sampling event, as would be expected with heavier chlorinated compounds. However, since concentrations in well HL-90-1 have been decreasing with time, a similar trend is predicted for well HL-10-1. According to the potentiometric map in Figure 2-2, groundwater flow through well MPC-1 heads directly for the groundwater extraction and should be extracted and treated. Concentrations of PCE in extraction well HL-99-3 show a statistically decreasing trend.

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DATA VALIDATION REPORT CITY OF PEORIA, ILLINOIS

Prepared by: [Redacted]

Date: 8/11/10

Page: 1 of 1

APPENDIX A

DATA VALIDATION REPORT

Page: 1 of 1

Date: 8/11/10

Page: 1 of 1

Date: 8/11/10

Page: 1 of 1

**DATA VALIDATION REPORT
CITY OF HELENA LANDFILL**

Groundwater Samples Collected in

June 2010

(Semi-Annual Sampling)

Prepared by
Hydrometrics, Inc.
3020 Bozeman Avenue
Helena, MT 59601

July 2010

TABLE OF CONTENTS

LIST OF APPENDICES	II
GLOSSARY OF TERMS.....	III
SUMMARY	1
1. INTRODUCTION.....	3
2. DELIVERABLES.....	4
3. FIELD QUALITY CONTROL SAMPLES	4
4. LABORATORY PROCEDURES.....	5
5. DETECTION LIMITS	6
6. LABORATORY BLANKS.....	6
7. LABORATORY BLANK SPIKES.....	6
8. SURROGATE SPIKES	7
9. MATRIX SPIKE /MATRIX SPIKE DUPLICATES (MS/MSD).....	7
10. INTERPARAMETER RELATIONSHIPS.....	7
11. HISTORICAL COMPARISON.....	8
12. DATA QUALITY OBJECTIVES	8
REFERENCES	9

LIST OF APPENDICES

APPENDIX 1: TABLES

TABLE 1 – Data Validation Codes and Definitions

TABLE 2 – Historical Comparison

TABLE 3 – Summary of Flagged Data

APPENDIX 2: DATABASE

APPENDIX 3: HYDROMETRICS FIELD NOTES

APPENDIX 4: ENERGY LABORATORIES ANALYTICAL REPORT

GLOSSARY OF TERMS

CCB.....	Continuing Calibration Blank
CCV	Continuing Calibration Verification
CLP	Contract Laboratory Program
CRDL.....	Contract Required Detection Limit
FAA	Flame Atomic Absorption
GFAA.....	Graphite Furnace Atomic Absorption
HGAA.....	Hydride Generation Atomic Absorption
ICB.....	Initial Calibration Blank
ICP	Inductively Coupled Plasma
ICV.....	Initial Calibration Verification
IDL.....	Instrument Detection Limit
LCS	Laboratory Control Sample
MSA.....	Method of Standard Additions
PB.....	Preparation Blank
PRDL	Project Required Detection Limit
QAPP	Quality Assurance Project Plan
QC	Quality Control
RPD.....	Relative Percent Difference
RSD.....	Relative Standard Deviation
SOW.....	Statement of Work
TDS.....	Total Dissolved Solids

SUMMARY

Laboratory analysis for groundwater samples collected for the June 2010 sampling event as part of the City of Helena Landfill have been reviewed and validated. This review has been in accordance with the "Revised Sampling and Analysis Plan; City of Helena Landfill; Groundwater, Surface Water, and Landfill Gas Monitoring Activities" (Hydrometrics, March 2008). All samples were analyzed at Energy Laboratories in Helena, Montana.

Data results are qualified when associated field quality control samples have not met validation criteria. Not all quality control deficiencies are equally serious and some may not have any practical impact on the usefulness of the data. A summary of quality control violations found in this validation follows:

Violations involving field quality control samples:

- In the field duplicate pair, HL-1006-117 and HL-1006-118 (HL-90-3), one exceedance occurred for chemical oxygen demand resulting in four associated data being flagged.

Violations involving laboratory quality control samples:

- In the QA/QC Summary Report provided by Energy Laboratories, matrix spike and matrix spike duplicate review showed several exceedances. However, at this level of validation, laboratory exceedances are noted but no flagging of the data occurs.
- It should also be noted that Energy Laboratories raised the reporting limit of sulfate, nitrate + nitrite as n, chloride, and cyanide due to sample matrix interference. The reporting limits used for dissolved antimony and thallium were lower than the requested limits, and did not seem to impact the results.
- Energy Laboratories exceeded the holding time for pH for all samples submitted. However, as a rule holding times for laboratory pH measurements are frequently exceeded because measurements are typically not conducted "immediately", but rather as soon as practicable. Therefore, no qualifiers are applied for lab pH holding time exceedances.
- It should be noted that Energy Laboratories used a different method than stated in the work plan on the following parameters: pH, SC, cyanide, and several metals analysis.

However, no associated data was flagged because the methods used are considered comparable to stated methods in work plan.

Deviations from the prescribed quality control procedures and/or exceedances of quality control limits have been noted, and results have been flagged in the database. The data quality objectives for accuracy and precision were met, as 97 percent of the field quality control sample results were within control limits and 97 percent of the laboratory quality control samples were within limits. The frequency requirements of 10 percent submittal of blanks, duplicates, control standards and spikes were met. The recommended project completeness goal, acceptance of 90 percent of the results as valid, has also been met as no results have been rejected as a result of this data review. Further discussion of data quality objectives is in Section 12 of the data validation report. All tables are in Appendix 1: data validation codes and definitions are listed in Table 1; a brief summary of flagged data is in Table 2; and a historical comparison is in Table 3. A database printout of this sampling event is located in Appendix 2. The Hydrometrics field notes are in Appendix 3. Energy Laboratories Analytical Reports are located in Appendix 4.

10-001	10-001-101	10	10	10	10
10-002	10-002-102	10	10	10	10
10-003	10-003-103	10	10	10	10
10-004	10-004-104	10	10	10	10
10-005	10-005-105	10	10	10	10
10-006	10-006-106	10	10	10	10
10-007	10-007-107	10	10	10	10
10-008	10-008-108	10	10	10	10
10-009	10-009-109	10	10	10	10
10-010	10-010-110	10	10	10	10
10-011	10-011-111	10	10	10	10
10-012	10-012-112	10	10	10	10
10-013	10-013-113	10	10	10	10
10-014	10-014-114	10	10	10	10
10-015	10-015-115	10	10	10	10
10-016	10-016-116	10	10	10	10
10-017	10-017-117	10	10	10	10
10-018	10-018-118	10	10	10	10
10-019	10-019-119	10	10	10	10
10-020	10-020-120	10	10	10	10
10-021	10-021-121	10	10	10	10
10-022	10-022-122	10	10	10	10
10-023	10-023-123	10	10	10	10
10-024	10-024-124	10	10	10	10
10-025	10-025-125	10	10	10	10
10-026	10-026-126	10	10	10	10
10-027	10-027-127	10	10	10	10
10-028	10-028-128	10	10	10	10
10-029	10-029-129	10	10	10	10
10-030	10-030-130	10	10	10	10
10-031	10-031-131	10	10	10	10
10-032	10-032-132	10	10	10	10
10-033	10-033-133	10	10	10	10
10-034	10-034-134	10	10	10	10
10-035	10-035-135	10	10	10	10
10-036	10-036-136	10	10	10	10
10-037	10-037-137	10	10	10	10
10-038	10-038-138	10	10	10	10
10-039	10-039-139	10	10	10	10
10-040	10-040-140	10	10	10	10
10-041	10-041-141	10	10	10	10
10-042	10-042-142	10	10	10	10
10-043	10-043-143	10	10	10	10
10-044	10-044-144	10	10	10	10
10-045	10-045-145	10	10	10	10
10-046	10-046-146	10	10	10	10
10-047	10-047-147	10	10	10	10
10-048	10-048-148	10	10	10	10
10-049	10-049-149	10	10	10	10
10-050	10-050-150	10	10	10	10
10-051	10-051-151	10	10	10	10
10-052	10-052-152	10	10	10	10
10-053	10-053-153	10	10	10	10
10-054	10-054-154	10	10	10	10
10-055	10-055-155	10	10	10	10
10-056	10-056-156	10	10	10	10
10-057	10-057-157	10	10	10	10
10-058	10-058-158	10	10	10	10
10-059	10-059-159	10	10	10	10
10-060	10-060-160	10	10	10	10
10-061	10-061-161	10	10	10	10
10-062	10-062-162	10	10	10	10
10-063	10-063-163	10	10	10	10
10-064	10-064-164	10	10	10	10
10-065	10-065-165	10	10	10	10
10-066	10-066-166	10	10	10	10
10-067	10-067-167	10	10	10	10
10-068	10-068-168	10	10	10	10
10-069	10-069-169	10	10	10	10
10-070	10-070-170	10	10	10	10
10-071	10-071-171	10	10	10	10
10-072	10-072-172	10	10	10	10
10-073	10-073-173	10	10	10	10
10-074	10-074-174	10	10	10	10
10-075	10-075-175	10	10	10	10
10-076	10-076-176	10	10	10	10
10-077	10-077-177	10	10	10	10
10-078	10-078-178	10	10	10	10
10-079	10-079-179	10	10	10	10
10-080	10-080-180	10	10	10	10
10-081	10-081-181	10	10	10	10
10-082	10-082-182	10	10	10	10
10-083	10-083-183	10	10	10	10
10-084	10-084-184	10	10	10	10
10-085	10-085-185	10	10	10	10
10-086	10-086-186	10	10	10	10
10-087	10-087-187	10	10	10	10
10-088	10-088-188	10	10	10	10
10-089	10-089-189	10	10	10	10
10-090	10-090-190	10	10	10	10
10-091	10-091-191	10	10	10	10
10-092	10-092-192	10	10	10	10
10-093	10-093-193	10	10	10	10
10-094	10-094-194	10	10	10	10
10-095	10-095-195	10	10	10	10
10-096	10-096-196	10	10	10	10
10-097	10-097-197	10	10	10	10
10-098	10-098-198	10	10	10	10
10-099	10-099-199	10	10	10	10
10-100	10-100-200	10	10	10	10

DATA VALIDATION REPORT

1. INTRODUCTION

This validation applies to organic analytes for 32 water samples collected for the City of Helena Landfill semi-annual monitoring project during the June 2010 sampling event. The total number of samples included: four field observations, one field duplicate, two field blanks (DI and Rinsate) and one trip blank.

All samples were submitted for volatile organic analyses, and select samples were submitted for inorganic analyses (metals and wet chemistry) as follows:

SITE CODE	SAMPLE NUMBER	WATER LEVEL	FIELD PARAMETERS ¹	METALS AND COMMONS ²	VOLATILES METHOD 8260 ³
INF GALLERY	HL-1006-103	X	X		X
MPC-2	HL-1006-108		X		X
Res #16	HL-1006-107		X		X
Res #5	HL-1006-114		X		X
Res #40	HL-1006-106		X		X
Res # 57	HL-1006-111		X		X
Res #52	HL-1006-105		X		X
Res #48	HL-1006-110		X		X
I-4	HL-1006-126	X			X
Res #62	HL-1006-112		X		X
HL-90-2	HL-1006-109	X	X	X	X
HL-06-1	HL-1006-116	X	X	X	X
HL-90-3	HL-1006-117	X	X	X	X
HL-90-3 DUP	HL-1006-118		X	X	X
HL-94-1R	HL-1006-113	X	X	X	X
HL-94-2R	HL-1006-119	X	X	X	X
HL-94-3	HL-1006-115	X	X	X	X
HL-90-1	HL-1006-121	X			
MPC-1	HL-1006-122	X	X	X	X
DI BLANK	HL-1006-124		X	X	X
EPA-1	HL-1006-104	X	X	X	X
MPC-5	HL-1006-123	X	X	X	X
HL-99-1	HL-1006-102	X	X	X	X
HL-10-01	HL-1006-120	X	X	X	X
HL-99-2	HL-1006-101	X	X	X	X
HL-99-3	HL-1006-100	X	X	X	X
RINSATE BLANK	HL-1006-125		X	X	X
TRIP BLANK	HL-1006-127				X
I-1	HL-1006-128	X			
82-3	HL-1006-129	X			
EPA-2	HL-1006-130				
EPA-4	HL-1006-131	X			

1.) Field parameters include pH, SC, and water temperature.

2.) Metals and commons include those compounds listed in the first half of ARM 17.50.708 Table 1.

3.) Volatile organic compounds include those listed in the second half of ARM 17.50.708 Table 1.

- Validation procedures used are generally consistent with:

(Check all that apply)

- ☒ EPA CLP National Functional Guidelines for Inorganics Data Review
- ☒ EPA CLP National Functional Guidelines for Organic Data Review
- ☒ Work Plan (Sampling and Analysis Plan, City of Helena Landfill Groundwater Monitoring Activities, Hydrometrics, March 2008)

- Overall level of validation:

- ☐ Contract Laboratory Program (CLP)
- ☒ Standard (see following notes)
- ☐ Visual

NOTES: The review of this data includes checking all field and laboratory quality control samples; flagging for exceedances in field quality control; and calculating precision, accuracy, and completeness for both laboratory and field quality control samples.

2. DELIVERABLES

- All laboratory document deliverables were present as specified in the CLP-Statement of Work (CLP-SOW), EPA, 1993 and/or the project contract.

☒ Yes
☐ No

- All documentation of field procedures was provided as required.

☒ Yes
☐ No

- Consistency with project requirements

Sampling was completed in order as stated in the SAP.

☒ Yes (see following notes)
☐ No

NOTES: It should be noted that the wells were not sampled in the order listed in the SAP. The order of sampling was followed for all wells that do not use dedicated or disposable equipment. Any variances in sampling order were noted in the field book.

3. FIELD QUALITY CONTROL SAMPLES

- Field blanks

Please note that the highest blank value associated with any particular analyte is the blank value used for the flagging process.

DI, trip, rinsate, or any other field blanks have been carried out at the proper frequency.

☒ Yes
☐ No

Reported results on the field blanks are less than the contract required detection limits (CRDL) or the project required detection limits (PRDL) if project detection limits have been specified.

☒ Yes
☐ No

- **Field duplicates**

Field duplicates have been collected at the proper frequency.

☒ Yes

☐ No

Field duplicate relative percent differences (RPD's) were within the required control limits (RPD of 20 percent or less for water matrix, 35 percent or less for soil matrix). If the sample or duplicate result is less than 5 times the PRDL, the RPD criteria are not used. In these cases, the difference between the sample and the duplicate results must be within $\pm$ the PRDL for water matrix, within $\pm$ 2 times the PRDL for soil matrix.

☐ Yes

☒ No (see the following notes)

NOTES: In field duplicate sample pair, HL-1006-117 and HL-1006-118 (HL-90-3), one exceedance occurred for chemical oxygen demand resulting in four associated results being flagged.

- **Field standards**

Field standards were sent at the proper frequency

☐ Yes

☐ No

☒ NA - Not required by the work plan.

4. **LABORATORY PROCEDURES**

- **Laboratory procedures followed**

☐ CLP-SOW

☒ SW-846

☒ Methods for Chemical Analysis of Water and Wastes

☐ XRF Standard Operating Procedures

☐ Other

- **Samples were received by the laboratory at the proper temperature**

☒ Yes

☐ No

- **Holding times met**

☐ Yes

☒ No (see the following notes)

NOTES: Energy Laboratories exceeded the holding time for pH for all samples submitted. However, as a rule holding times for laboratory pH measurements are frequently exceeded because measurements are typically not conducted "immediately", but rather as soon as practicable. Therefore, no qualifiers are applied for lab pH holding time exceedances.

- **Consistency with project requirements**

Analyses were carried out as requested.

☒ Yes

☐ No

Project specified methods were used.

☒ Yes (see following notes)

☐ No

NOTES: It should be noted that Energy Laboratories used a different method than stated in the work plan on the following parameters: pH, SC, cyanide, and several metals analysis. However, no associated data was flagged because the methods used are considered comparable to stated methods in work plan.

5. DETECTION LIMITS

- Reporting detection limits met project required detection limits (PRDL).

☒ Yes (see following notes)

☐ No

NOTES: It should be noted that Energy Laboratories raised the reporting limit for sulfate, nitrate + nitrite as n, chloride, and cyanide due to a sample matrix interference. The reporting limits used for dissolved antimony and thallium were lower than the requested limits, and did not seem to impact the results.

6. LABORATORY BLANKS

Please note that the highest blank value associated with any particular analyte is the blank value used for the flagging process.

- Preparation/Method blanks**

Preparation/Method blanks were prepared and analyzed at the required frequency.

☒ Yes

☐ No

All analytes in the preparation blank were less than the CRDL (or PRDL if a project detection limit has been specified).

☒ Yes

☐ No

7. LABORATORY BLANK SPIKES

- Blank Spikes**

Blank spikes (organics) were prepared and analyzed at the required frequency.

☒ Yes

☐ No

Blank spike recoveries were within control limits.

☒ Yes

☐ No

8. SURROGATE SPIKES

- **Surrogate Spikes**

Surrogate spikes were prepared and analyzed at the required frequency.

☒ Yes

☐ No

Surrogate spike recoveries were within control limits.

☒ Yes

☐ No

9. MATRIX SPIKE /MATRIX SPIKE DUPLICATES (MS/MSD)

- Matrix spike samples were analyzed at the proper frequency.

☒ Yes

☐ No

Matrix spike recoveries were within control limits.

☐ Yes

☒ No (see following notes)

- Matrix spike duplicate samples were analyzed at the proper frequency.

☒ Yes

☐ No

Matrix spike duplicate RPD's were within control limits.

☐ Yes

☒ No (see following notes)

NOTES: Both matrix spike and matrix spike duplicate samples had several QC exceedances. At this level of validation, these exceedances are only noted and no flagging of the associated data occurs.

10. INTERPARAMETER RELATIONSHIPS

- The following relationships have been checked for all data from the June 2010 monitoring:

☒ Lab SC versus field SC

☒ Lab pH versus field pH

Lab SC versus field SC: A comparison of the field and lab SCs using a percent difference (%D) criteria for evaluation purposes, showed that one of the SC pairs exceeded the ten percent comparison criteria.

Lab pH versus field pH: A comparison of the field and lab pHs using a percent difference (%D) criteria for evaluation purposes, showed that also one of the pH pairs exceeded the ten percent comparison criteria.

11. HISTORICAL COMPARISON

Current sampling event data (June 2010) were compared to historical data (June 2007 through May 2010). The data for the June 2010 sampling event was similar to historic data.

12. DATA QUALITY OBJECTIVES

- Project data quality objectives (DQO's) met.

☒ Yes

☐ No

Accuracy

Accuracy for this project is the agreement between a measured value and a true value and is measured by the recoveries on the laboratory matrix spikes and laboratory control samples.

Accuracy for this sampling event was 98 percent.

Precision

Precision for this project is the degree of variability between duplicate measurements. Laboratory analytical variability is measured by laboratory duplicates; field duplicates are a measure of overall variability in both field sampling and laboratory techniques.

Laboratory precision was 97 percent for this sampling event.

Field precision was 97 percent for this sampling event.

Completeness

The target completeness for this project is 90 percent of the measurements valid (not rejected). This percentage is based on the number of valid measurements compared to the number of planned measurements. Completeness for this sampling event was 100 percent.

DATA VALIDATION REPORT

Prepared by: Ericka Vallance

Reviewed by: Jodi Bingham, P.E.

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Water Validation and Statistics
Evaluation of June 2010
Groundwater Quality Data

City of Helena Landfill
Appendix A - Data Validation (Appendices Only)

August 2010

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APPENDIX B

STATISTICAL ANALYSIS REPORTS

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August 2010

Appendix B - Statistical Analysis Reports
City of Helena Landfill
Groundwater Quality Data
Data Validation and Statistical
Evaluation of June 2010

